IN THE SPECIFICATION

Please delete paragraph [0001] and replace with the following new paragraph. Changes from the original are highlighted.

[0001] This application is a continuation-in-part of pending U.S. Patent Application Serial No. 09/728,373, "Optical Communications System Using Heterodyne Detection", by Ting K. Yee and Peter H. Chang, filed November 28, 2000, which is a continuation-in-part of pending U.S. Patent Application Serial No. 09/474,659, "Optical Communications System Using Heterodyne Detection", by Ting K. Yee and Peter H. Chang, filed December 29, 1999 (now abandoned).

Please delete paragraph [0003] and replace with the following new paragraph. Changes from the original are highlighted.

[0003] This application relates to pending U.S. Patent Application Serial No. 09/746,261, "Wavelength-Locking of Optical Sources," by Shin-Sheng Tarng, et al., filed December 20, 2000 (now U.S. Patent 6,493,131, issued December 10, 2002).

Please delete paragraph [0004] and replace with the following new paragraph. Changes from the original are highlighted.

[0004] This application also relates to pending U.S. Patent Application Serial No. 09/747,261, "Fiber Optic Communications using Optical Single Sideband Transmission and Direct Detection," by Ting K. Yee, ~~and~~ Peter H. Chang, and James F. Coward, filed December 20, 2000.

Please delete paragraph [0005] and replace with the following new paragraph. Changes from the original are highlighted.

[0005] This application also relates to pending U.S. Patent Application Serial No. 09/854,153, "Channel Gain Control For An Optical Communications System Utilizing Frequency Division Multiplexing," by Laurence J. Newell and James F. Coward, filed May 11, 2001; and pending U.S. Patent Application Serial No. 09/569,761, "Channel Gain Control For An Optical Communications System Utilizing Frequency Division Multiplexing," by Laurence J. Newell and James F. Coward, filed May 12, 2000 (now abandoned).

Please delete paragraph [0006] and replace with the following new paragraph. Changes from the original are highlighted.

[0006] This application also relates to pending U.S. Patent Application Serial No. 09/405,367, "Optical Communications Networks Utilizing Frequency Division Multiplexing," by Michael W. Rowan, et al., filed Sept. 24, 1999 (now U.S. Patent No. 6,529,303, issued March 4, 2003); which is a continuation-in-part of pending U.S. Patent Application Serial No. 09/372,143, "Optical Communications Utilizing Frequency Division Multiplexing and Wavelength-Division Multiplexing," by Peter H. Chang, et al., filed August 20, 1999 (now abandoned); which is a continuation-in-part of U.S. Patent Application Serial No. 09/229,594, "Electrical Add-Drop Multiplexing for Optical Communications Networks Utilizing Frequency Division Multiplexing," by David B. Upham, et al., filed January 13, 1999 (now U.S. Patent 6,452,945, issued Sept. 17, 2002); which is a continuation-in-part of U.S. Patent Application Serial No. 09/035,630, "System and Method for Spectrally Efficient Transmission of Digital Data over Optical Fiber", by Michael W. Rowan, et al., filed March 5, 1998 (now abandoned).

Please delete paragraph [0059] and replace with the following new paragraph. Changes from the original are highlighted.

[0059] At receiver 130, heterodyne detector 180 receives 235 the incoming optical signal 142 and also receives 240 an optical local oscillator signal 134 at a frequency f_{Lo}. In FIG. 1, the local oscillator signal 134 is shown at a frequency f_{Lo} which is lower than the carrier frequency f_c but the local oscillator signal 134 may also be located at a frequency f_{Lo} which is higher than the carrier frequency f_{Lo}. Examples of optical local oscillators 132 include solid state lasers and semiconductor lasers. The optical signal 142 and local oscillator signal 134 are combined 245 and heterodyne detection 250 of the combined signal effectively downshifts the optical signal 142 from a carrier at frequency f_c to a frequency Δf, which is the difference between the local oscillator frequency f_{Lo} and the carrier frequency f_c. The resulting electrical signal has spectrum 150. Note that both sidebands 154L and 154U, and tone 156 have also been frequency downshifted compared to optical signal 142. Signal extractor 190 then mixes 260 at least one of the sidebands 154 with one of the tones 156 to produce a number of frequency components, including one frequency component 170 located at the difference frequency ~~Δf~~ between the relevant sideband 154 and tone 156. This difference component 170 contains the information signal 140, although it may be offset in frequency from the original frequency f_s, depending on the frequencies of the sideband 154 and tone 156. Frequency components other than the difference component 170 may be used to recover the information signal. For example, the mixing 260 typically also produces a sum component located at the sum of the frequencies of the relevant sideband 154 and tone 156, and the information signal 140 may be recovered from this sum component rather than the difference component. If more than one sideband 154 is processed by signal extractor 190, each sideband 154 is processed separately from the others in a manner which prevents destructive interference between the sidebands.

Please delete paragraph [0063] and replace with the following new paragraph. Changes from the original are highlighted.

[0063] In a preferred embodiment, the polarization controller 139 matches the polarization of the local oscillator 134 to the polarization of the tone 146. This matching is particularly advantageous when a polarization tracking algorithm is used because the tone 146 is stable and does not have substantial amplitude variation and therefore provides better locking of the polarizations. In fibers having measurable polarization mode dispersion,. after propagation through the fiber, each sideband 144 and the tone 146 can have slightly different polarizations, thus resulting in attenuation of the detected electrical signal due to the polarization mismatch. Generally, the further the separation in frequency between the sideband 144 and the tone 146, the stronger the attenuation of the detected electrical signal. This attenuation can be mitigated by boosting the transmit power of the affected subbands. For examples of methods for mitigating the attenuation of power in the subbands of the detected electrical signals, including boosting the transmit power of subbands, see co-pending U.S. Patent Application Serial No. 09/854,153, "Channel Gain Control For An Optical Communications System Utilizing Frequency Division Multiplexing," by Laurence J. Newell and James F. Coward, filed May 11, 2001; and ~~co-pending~~ U.S. Patent Application Serial No. 09/569,761, "Channel Gain Control For An Optical Communications System Utilizing Frequency Division Multiplexing," by Laurence J. Newell and James F. Coward, filed May 12, 2000 <u>(now abandoned)</u>.

Please delete paragraph [0092] and replace with the following new paragraph. Changes from the original are highlighted.

[0092] In more detail, transmitter subsystem 1202 includes four electrical transmitters 1208A-1208D which are electrically coupled to an FDM multiplexer 1209, which in turn is coupled to transmitter 1210. Each electrical transmitter 1208 includes the same construction as element 245 in FIG. 6B of ~~co-pending~~ U.S. Patent Application Serial No. 09/405,367, "Optical Communications Networks Utilizing Frequency Division Multiplexing," by Michael W. Rowan, et al., filed Sept. 24, 1999 (hereafter, the "FDM Application"<u>, now U.S. Patent 6,529,303</u>). In brief, electrical transmitter 1208 includes a QAM modulator (included in element 640 of FIG. 6B) coupled to an FDM multiplexer (elements 642 and 644 in FIG. 6B). Each electrical transmitter 1208 receives 64 incoming electrical low-speed channels 1222, each of

which has a data rate of 155 Mbps in this specific embodiment. The QAM modulator applies a QAM modulation to each incoming lowspeed channel. The FDM multiplexer combines the QAM-modulated low-speed channels using FDM techniques to form an electrical channel 1224A-1224D which has a data rate of 10 Gbps and a width of approximately 5.5 GHz. The frequency spectra of signals 1224A and 1224D are shown in FIG. 13A. See also FIG. 10D, et seq. in the FDM Application.

Please delete paragraph [0110] and replace with the following new paragraph. Changes from the original are highlighted.

[0110] Optical signal 1660B is similarly structured, containing two optical sidebands 1668B and a suppressed carrier 1669B. Each optical sideband 1668B includes two subbands 1662B and 1666B, and a tone 1664B. The subbands 1662B and ~~1668B~~ <u>1666B</u> are different from the subbands 1662A and 1666A; so in this example, there are a total of four subbands carrying different information. Optical signals 1660A and 1660B are also different in that they are orthogonally polarized. In one embodiment, they have crossed linear polarizations. In FIG. 16, the orthogonal polarizations are indicated by the orientation of the spectra. For example, spectra 1660A is oriented in the plane of the paper, indicating one polarization; while spectra 1660B is oriented coming out of the paper, indicating an orthogonal polarization. In addition, the two optical signals 1660 use optical carriers 1669 of different wavelengths. In an alternate embodiment, the optical signals 1660 are orthogonally polarized but not using crossed linear polarizations. For example, one signal 1660A may be right circularly polarized; whereas the other signal 1660B is left circularly polarized. In another embodiment, the two optical signals have different polarization but may not be completely orthogonally polarized to each other.

Please delete paragraph [0116] and replace with the following new paragraph. Changes from the original are highlighted.

[0116] The resulting composite optical signal 1690 includes the upper sideband 1668A(U) from optical signal 1660A and the orthogonally polarized lower sideband 1668B(L) from optical signal 1660B. Each of the four subbands of composite optical signal 1690 carries different information, for example a different 10 Gbps data stream in one embodiment. Note that composite optical signal 1690 is a single sideband signal in that only one optical sideband of each subband is transmitted. The other optical sideband was removed by filter 1615. System 1600 is merely one example of an approach capable of generating optical single sideband signals. For example, see FIGS. 3-5 of ~~co-pending~~ U.S. Patent Application Serial No. 09/747,261, "Fiber Optic Communications using Optical Single Sideband Transmission and Direct Detection," by Ting K. Yee, ~~and~~ Peter H. Chang, <u>and James F. Coward</u> filed December 20, 2000 <u>(now abandoned)</u>.

Please delete paragraph [0132] and replace with the following new paragraph. Changes from the original are highlighted.

[0132] The same approach is used to wavelength-lock the optical carrier 1669B generated by optical source 1712B. In FIG. 18B, the nominal wavelength <u>1875</u> of carrier 1669B is also located at 6 dB of attenuation, but at the upper edge of the filter transfer function. Thus, too much attenuation means the wavelength is too high, and too little attenuation means the wavelength is too low.

Please delete paragraph [0134] and replace with the following new paragraph. Changes from the original are highlighted.

[0134] As usual, the wavelength locking device 1800 in FIG. 18A is merely an example. Other approaches to wavelength-locking may also be used, including those discussed in ~~co-pending~~

U.S. Patent Application Serial No. ~~09/746,261~~ 09/746,370, "Wavelength-Locking of Optical Sources," by Shin-Sheng Tarng, et al., filed December 20, 2000 (now U.S. Patent 6,493,131, issued December 10, 2002).

Please delete paragraph [0142] and replace with the following new paragraph. Changes from the original are highlighted.

[0142] FIG. 21 is a block diagram of another -embodiment 2500 of receiver subsystem 1604. This particular receiver subsystem 2500 includes an optical splitter ~~2532~~ 2533 coupled to two heterodyne receivers 2530A-B. Each receiver 2530 processes one of the two orthogonally polarized signals 1668A(U) and 1668B(L), respectively, using heterodyne techniques, for example as described previously. Subbands 2562A and 2566A use tone 2564A in the heterodyne detection. Similarly, subbands 2562B and 2566B use tone 2564B. The splitter ~~2532~~ 2533 splits the received composite optical signal 2590 into two optical signals 2592A-B, one for each heterodyne receiver 2530. Each optical signal 2592 includes the relevant two subbands plus tone. Placing the tone between the two subbands reduces the frequency separation between tone and subband, thereby minimizing the attenuation of the detected electrical signal due to polarization mode dispersion. In this implementation, the optical splitter ~~2532~~ 2533 includes optical splitter coupled to two optical filters 2535A-B. As before, the polarization controller in the receivers 2530 matches the polarization of the local oscillator to the polarization of the tone.

Please delete paragraph [0144] and replace with the following new paragraph. Changes from the original are highlighted.

[0144] FIG. 23 shows composite optical signal 2290 in more detail. The graph shows power as a function of frequency and the figures below the graph illustrate the corresponding polarization states. As shown in the power spectrum, the optical signal 2290 includes sixteen subbands (or channels) 2294A-~~2194P~~2294P, tone 2296, and suppressed carrier 2297. The lower optical sideband of optical signal 2290 is substantially attenuated. As a consequence of the birefringence, the polarization of each channel is slightly different. In

this example, channel 1 (i.e., ~~2794A~~ 2294A) is linearly polarized 2298A and channel 16 (~~2794P~~ 2294P) is similarly linearly polarized 2298E. In between, the phase retardation varies continuously, so that the polarization gradually transforms from linear vertical 2298A, to right circular 2298B, to linear horizontal 2298C, to left circular 2298D, back to linear vertical 2298E. The polarizations generally are elliptical. The varying polarization serves to reduce four-wave mixing and cross-phase modulation between the channels.

Please delete the abstract and replace with the following new abstract. Changes from the original are highlighted.

A transmitter subsystem generates an optical signal which contains multiple subbands of information. The subbands have different polarization. For example, in one approach, two or more optical transmitters generate optical signals which have different polarization. An optical combiner optically combines the optical signals into a composite optical signal for transmission across an optical fiber. ~~In another approach, a single optical transmitter generates an optical signal with multiple subbands. The polarization of the subbands is varied, for example by using a birefringent crystal.~~ In another aspect ~~of the invention~~, each optical transmitter generates an optical signal containing both a lower optical sideband and an upper optical sideband (i.e., a double sideband optical signal). An optical filter selects the upper optical sideband of one optical signal and the lower optical sideband of another optical signal to produce a composite optical signal.